PEST MANAGEMENT GRANTS FINAL REPORT

Title: Demonstration of Vineyard Floor Management Alternatives

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Abstract

Runoff of pesticides from agricultural land is a key water quality concern in the Central Coast of California for water quality concerns as well as for concerns regarding the National Marine Sanctuary. Growers are under increasing pressure to reduce runoff and associated sediment and pesticide loads. As a result of these concerns, proactive grower groups such as the Central Coast Vineyard Team (CCVT) have formed to address negative environmental aspects of grape production while maintaining crop quality and yield. This project works with a management team composed of members of the CCVT, growers, and U.C. farm advisors and specialists to evaluate various vineyard floor management practices on weed control, the economics of production, the yield and quality of grapes, and the effects on soil physical characteristics and runoff. A 7.0 acre long-term demonstration plot was established in Greenfield, CA with cooperating growers. This standard weed control practice (preemergence application of simazine+oxyfluorfen) that is commonly used on the vine rows in the Central Coast Region of California is being compared against two alternative weed control practices: 1) cultivation and 2) 100% postemergence herbicide. Within each weed control practice three cover crop practices are planted in the row middles: 1) no cover crop; 2) Merced rye; and 3) Trios 102. This project is focused on evaluating the long-term effect of these vineyard floor management alternatives on crop yield and quality, weed control, crop nutrition, runoff, and soil physical parameters.

The Clemens cultivator had higher weed populations early and though out the growing season except for the second evaluation date in spite of monthly cultivations. The post emergence treatment had a high population of marestail (*Conyza canadensis*) on the

second sampling date and populations of yellow nutsedge (*Cyperus esculentus*) did not differ between the weed control treatments. Results from partial budget analyses show that costs range from a low of $87 per acre for the post-emergence/bare ground treatment combination to a high of $150 per acre for the Clemens cultivation/Trios 102 treatment combination. The former treatment combination has both lower equipment and material input costs than other treatment combinations, while the latter has higher hand weeding and equipment use costs. There were higher levels of some nutrients in the uncover cropped row middles and even on the row berms (i.e. NO_3, EC and Cl). There were no runoff events in the 2001-02 season and the there were no significant differences in the yields or quality of the grapes this year.

Extension activities include a vineyard floor management field day held on June 11, 2002. This meeting was attended by 45 growers from Monterey, Santa Cruz, San Luis Obispo and San Benito Counties. The results of years one and two of this project were presented at the Central Coast Wine Grape Seminar held on February 18 in Salinas, 2002. This meeting was attended by 60 growers and allied industry representatives from Monterey, Santa Cruz and San Benito Counties.

Report

Objective No. 1

Compare a standard vineyard floor management practice with alternative strategies with regards to weed control efficacy, impacts on crop yield and quality, impacts on runoff and soil physical properties and the economics of the alternatives. In order to achieve this objective, a large-scale demonstration plot will be established with grower cooperators and apply the standard weed control practice and two alternative practices. The demonstration plot will be monitored for weed control, amount of herbicide applied, affects on runoff and soil physical properties, yield and quality of grapes from each strip and the costs associated with each practice.

Results

A. A long-term test plot was established with cooperating growers Jason Smith and Daryl Salm in Greenfield in 2001. The establishment of a long-term demonstration/research plot of this size is a rare and significant resource. The plot is 23 vine rows wide (8 foot spacing) by 1660 feet long and totals 7.0 acres. The plot is planted to one clone of the cultivar Chardonnay on Teleki 5C rootstock. The soil type of the trial site is Elder Loam with gravelly substratum. The main plots are the three weed control treatments and within each weed control treatment the plots are divided in to three cover crop subplots. Cover crops are planted in the middle 32 inches of the 8-foot wide vine rows. The cover crops were planted with a drill on December 13, 2001. However, it grew poorly due to cold temperatures (table 1). Runoff was measured by burying PVC cylinders (16 inches in diameter by 5 feet deep) at the ends of each cover crop treatments in the standard weed control treatment (9 total cylinders) during the 2000-01 season. A total area of 550 feet long by 8 feet wide (4,400 ft^2) drained into each cylinder.

Vineyard floor management practices for 2002 are documented in table 3 and serve as the basis for economic evaluations. ***Runoff:*** There was no runoff event during the winter of 2001-02 and we were unable to make measurement of the impact of the cover crops on runoff (table 2). ***Weed control***: Weed control treatments were applied as appropriate for each practice (table 3). The impact of the various weed control strategies was evaluated by measuring frequency on five dates (tables 4-9). The Clemens cultivator had higher weed populations early and though out the growing season except for the second evaluation date in spite of monthly cultivations. The post emergence treatment had higher weed populations on the second evaluation date which indicated that the post emergence program needs to be more aggressive in controlling early season weeds, especially where marestail (*Conyza canadensis*) is present (table 6). Marestail was brought under good control by the use of Rely (glufosinate) after the second evaluation date. Populations of yellow nutsedge (*Cyperus esculentus*) did not differ between the weed control treatments (tables 5-9). Plots with cover crops in the row middles had higher populations of weeds in the vine row berms on the first evaluation date (table 4). ***Crop nutrition:*** The soil and plant tissue analyses for year one and two are shown in tables 10 – 16. There are few differences amongst the treatments in year one (2001), however the uncover cropped treatments had significantly greater nitrate-nitrogen (N) and phosphorus (P) in the soil of the vine rows than the cover cropped plots (table 10). There were no differences in the petiole or leaf blade tissue in year one. Higher nitrate was again observed in the vine rows of uncover cropped plots in year two (table 13). The electrical conductivity (EC) and chloride levels were also higher. The uncover cropped row middles had higher nitrate-N, P, EC and sodium (Na) (table 14). No significant difference were observed in tissue nutrient levels in year two (tables 15 and 16). ***Soil physical parameters:*** the soil physical parameter data for 2002 is not available at this time. ***Crop yield and quality:*** No differences in crop yield were observed in 2002 (tables 17 and 18). This may be partially a response to poor growth and stunting that occurred in the 2002 season. No differences in fruit quality were observed in 2002 as was seen in 2001 (table 17). ***Economic evaluation:*** To date, this project has documented field data for nine different vineyard floor management alternatives during the 2002 production cycle. Economic analyses (partial budgets) have been performed for each alternative, which include estimated costs for equipment use, fuel, lube and repairs, labor (machine and field), material inputs, and interest on operating capital. Alternatives were analyzed by treatment groups shown in tables 19-22. Results from partial budget analyses show that costs range from a low of $87 per acre for the post-emergence/bare ground treatment combination to a high of $150 per acre for the Clemens cultivation/Trios 102 treatment combination. The former treatment combination has both lower equipment and material input costs than other treatment combinations, while the latter has higher hand weeding and equipment use costs.

In evaluating results from the three treatment groups, the 'Clemens cultivation' group was the highest cost treatment group, attributed largely to the associated hand weeding and equipment use costs. The 'post-emergence' group was the lowest cost group due to the use of specialized herbicide application equipment, thus lower material input costs. The 'pre-emergence' group was the highest cost group because of the associated material (herbicide) costs.

B. We improved communication with the ranch foreman in 2002 and had few glitches in carrying out the research.

C. No changes were made to the established timetable or budget regarding this objective.

D. The feed back that we received from growers at the tailgate meeting, the Wine Grape Seminar and from informal conversations have been positive and supportive of the project and its goals. Growers are very interested in the relative costs of each practice and the first year of the project provided an opportunity to compare weed control and the relative costs of each practice. This information is fundamental for growers that are considering alternative weed control programs for their vineyards. The information on the impacts of the practices on the soil physical properties is also critical for growers to make informed decisions on the long-term impacts of the practices on vineyard productivity. In addition, growers are urging us to expand the scope of the investigations. In particular growers want more information on the impacts of the weed control and cover crop practices on the microbiological and nutritional components of the soil, and water usage. We appreciated the level of interest and support indicate that growers, and as a result, we applied to Western Sustainable Agriculture Research and Education Program (SARE) and received funding to look at the impact of these vineyard floor practices on soil microbiological aspects.

Objective No. 2:

Demonstrate the vineyard floor management strategies to growers.

Results:

A. Extension activities include a vineyard floor management field day held on June 11, 2002. This meeting was attended by 45 growers from Monterey, Santa Cruz, San Luis Obispo and San Benito Counties. The results of this project were discussed at the Central Coast Wine grape Seminar held on February 18 in Salinas, 2002. This meeting was attended by 60 growers and allied industry representatives from Monterey, Santa Cruz and San Benito Counties. The summary results of years one and two were presented and a thorough presentation on the costs of the practices were discussed.

B. This project is beginning to generate useful data for growers. And we expect as time goes by the value of the project and the information will increase.

C. No changes were made to the established timetable or budget regarding this objective.

Appendix A

Table 1. Cover crop biomass on three evaluation dates

Date	Feb 14	Mar 6	Apr 12
Rye	0.25	0.69	3.24
Trios 102	0.03	0.33	2.29
LSD (0.05)	0.13	0.25	0.90

Table 2. Rainfall during the winter of 20010-02

Date	Rainfall	Date	Rainfall	Date	Rainfall
12/01	0.06	12/29	0.23	3/17	0.39
12/02	0.16	12/30	0.28	3/22	0.03
12/03	0.16	1/02	0.40	3/23	0.27
12/04	0.05	1/28	0.05	3/24	0.01
12/09	0.20	2/16	0.22	Total rainfall	4.79
12/14	0.19	2/17	0.23		
12/20	0.24	3/5	0.39		
12/21	0.23	3/6	1.00		

Table 3. Vineyard floor management activities

Vineyard Floor Operation	**Date**	**Activity**	**Material**		**Date**	**Activity**
Weed Control				***Cover Crop***	Apr 20	Disc
Preemergence	Jan 29	Preemergence	Princep/ Roundup/ Goal		Apr 20	Mow
	May 21	Post emergence	Roundup/ Goal		June 4	Disc
	Aug 20	Post emergence	Roundup/ Goal		July 9	Disc
Clemens cultivator	Mar 6	Cultivation			July 9	Mow
	Apr 8	Cultivation			Aug 20	Disc
	May 8	Hand weed			Aug 20	Mow
	June 4	Cultivation				
	June 4	Sidedisc				
	July 9	Cultivation				
	Aug 15	Cultivation				
Post emergence	Mar 19	Post emergence	Roundup/ Goal			
	May 21	Post emergence	Roundup/ Goal/Rely			
	July 10	Post emergence	Roundup/ Goal			
	Aug 20	Post emergence	Roundup/ Goal			

Table 4. Summary of total weed frequency in weed treatments and cover crops on five sampling dates

Weed Treatment	March 28	May 9	June 24	July 29	Sept. 3
Standard Practice	3.2	11.5	15.9	16.1	15.1
Clemens	29.3	24.8	26.5	48.5	21.5
Post emergence	9.9	33.3	12.1	7.4	10.5
LSD (0.05)	5.8	13.6	9.7	9.9	4.5
Cover Crop					
Rye	16.4	27.9	15.6	23.0	15.5
Trios	17.4	23.7	21.2	24.2	16.1
Bare	7.4	17.7	17.8	24.7	15.6
LSD (0.05)	4.3	n.s.	n.s.	n.s.	n.s.

Table 5. Weed frequency on March 28, 2002

Weed Treatment	Nut grass	Mares tail	Cover Crop	Knot weed	Malva	Sow Thistle	Night shade	Lambs quarter	Sherpherds purse	Morning Glory	Purslane	Total weeds
Standard Practice	2.0	0.9	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2
Clemens	0.4	0.5	9.6	3.5	6.9	2.4	1.8	0.4	3.6	0.0	0.1	29.3
Post emergence	0.1	7.8	0.0	0.2	1.3	0.0	0.0	0.0	0.4	0.0	0.0	9.9
LSD (0.05)	0.9	5.3	0.9	5.9	7.6	1.8	2.2	0.7	1.2	n.s.	n.s.	5.8
Cover Crop												
Rye	0.9	2.6	4.3	2.5	3.2	0.8	0.9	0.1	1.0	0.0	0.0	16.4
Trios	0.7	4.9	5.2	1.5	3.9	0.1	0.0	0.0	1.2	0.0	0.1	17.4
Bare	0.9	1.7	0.0	0.1	1.1	1.6	0.9	0.3	1.8	0.0	0.0	7.4
LSD (0.05)	n.s.	n.s.	0.0	n.s.	n.s.	0.1	n.s.	n.s.	n.s.	n.s.	n.s.	4.3

Table 6. Weed frequency on May 9, 2002

Weed Treatment	Nut grass	Mares tail	Cover Crop	Knot weed	Malva	Sow Thistle	Night shade	Lambs quarter	Sherpherds purse	Morning Glory	Purslane	Total weeds
Standard Practice	8.2	1.3	0.2	0.3	0.1	0.0	0.1	0.0	0.0	1.2	0.0	11.5
Clemens	6.8	0.2	4.1	2.3	4.8	2.3	2.9	0.2	0.2	0.6	0.4	24.8
Post emergence	7.8	5.6	0.0	0.0	14.7	2.5	1.7	0.1	0.1	0.7	0.0	33.3
LSD (0.05)	n.s.	n.s.	2.0	n.s.	8.4	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	13.6
Cover Crop												
Rye	8.9	3.2	1.1	2.3	7.3	0.5	1.7	0.0	0.1	2.4	0.3	27.9
Trios	8.7	1.8	3.1	0.3	8.8	0.1	0.6	0.2	0.1	0.0	0.1	23.7
Bare	5.2	2.1	0.1	0.0	3.4	4.2	2.4	0.1	0.1	0.0	0.0	17.7
LSD (0.05)	0.5	0.4	0.1	0.3	0.2	0.1	0.2	n.s.	n.s.	0.1	n.s.	n.s.

Table 7. Weed frequency on June 24, 2002

Weed Treatment	Nut grass	Mares tail	Cover Crop	Knot weed	Malva	Sow Thistle	Night shade	Lambs quarter	Sherpherds purse	Morning Glory	Purslane	Total weeds
Standard Practice	12.8	2.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	15.9
Clemens	10.8	0.0	5.2	0.0	0.0	2.7	0.3	0.6	0.0	0.0	3.9	26.5
Post emergence	7.6	0.9	2.8	0.0	0.0	0.2	0.1	0.1	0.1	0.2	0.1	12.1
LSD (0.05)	n.s.	n.s.	4.0	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	3.8	9.7
Cover Crop												
Rye	8.6	0.4	2.9	0.0	0.0	0.7	0.7	0.2	0.0	0.3	1.9	15.6
Trios	12.6	1.5	4.0	0.0	0.0	0.1	1.0	0.2	0.1	0.2	1.3	21.2
Bare	10.0	0.9	2.0	0.0	0.0	2.1	1.8	0.2	0.0	0.0	0.8	17.8
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table 8. Weed frequency on July 29, 2002

Weed Treatment	Nut grass	Mares tail	Cover Crop	Knot weed	Malva	Sow Thistle	Night shade	Lambs quarter	Sherpherds purse	Morning Glory	Purslane	Total weeds
Standard Practice	11.5	2.6	1.4	0.0	0.0	0.1	0.0	0.0	0.6	0.0	0.0	16.1
Clemens	10.3	0.2	17.2	0.0	0.3	1.9	2.8	1.2	0.1	0.4	13.9	48.5
Post emergence	6.3	0.3	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.4
LSD (0.05)	n.s.	n.s.	11.2	n.s.	n.s.	n.s.	n.s.	0.9	n.s.	n.s.	6.1	9.9
Cover Crop												
Rye	8.6	0.2	6.2	0.0	0.2	0.6	0.2	0.2	0.2	0.1	6.4	23.0
Trios	6.5	1.8	9.1	0.0	0.1	0.8	0.9	0.7	0.1	0.3	3.9	24.2
Bare	13.1	1.0	4.1	0.0	0.0	0.7	1.7	0.3	0.3	0.0	3.5	24.7
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table 9. Weed frequency on September 3, 2002

Weed Treatment	Nut grass	Mares tail	Cover Crop	Knot weed	Malva	Sow Thistle	Night shade	Lambs quarter	Sherpherds purse	Morning Glory	Purslane	Total weeds
Standard Practice	10.8	2.4	0.1	0.0	1.7	0.1	0.0	0.0	0.1	0.0	0.0	15.1
Clemens	7.1	0.0	0.0	0.0	2.1	0.7	2.8	0.0	0.0	0.2	8.6	21.5
Post emergence	7.9	0.5	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	10.5
LSD (0.05)	6.11	4.99	0.25	n.s.	4.59	0.73	2.15	n.s.	n.s.	n.s.	0.25	4.5
Cover Crop												
Rye	9.3	0.3	0.1	0.0	1.5	0.0	0.2	0.0	0.1	0.1	3.8	15.5
Trios	8.3	1.4	0.0	0.0	2.5	0.3	0.6	0.0	0.0	0.1	2.7	16.1
Bare	8.1	1.2	0.0	0.0	1.9	0.4	2.0	0.0	0.0	0.0	2.0	15.6
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table 10. Soil analysis of the vine row berm, May 22, 2001

Weed Treatment	NO_3	P	Zn	pH	EC	Ca	Mg	Na	Cl	B	K	CEC	OM
Standard Practice	10.7	17.2	1.5	7.7	1.5	6.6	4.1	4.0	5.4	0.2	13.1	16.1	0.8
Clemens	17.3	22.0	2.0	7.5	1.9	9.1	5.7	4.5	6.7	0.2	20.0	15.9	0.9
Post emergence	14.1	19.2	2.5	7.6	1.8	8.2	5.1	4.3	6.1	0.3	18.4	16.4	0.9
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Cover Crop													
Rye	10.7	18.7	2.1	7.6	1.5	7.0	4.3	3.8	5.1	0.2	15.6	16.0	0.8
Trios	12.1	18.8	1.9	7.7	1.6	7.0	4.4	3.9	5.4	0.2	14.7	16.4	0.9
Bare	18.7	20.9	2.0	7.6	2.0	9.9	6.1	5.1	7.7	0.3	21.1	16.0	0.9
LSD (0.05)	3.2	2.8	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table 11. Nutrient analysis of grape Petioles, May 22, 2001

Weed Treatment	N	P	K	S	B	Ca	Mg	Zn	Mn	Fe	Cu	Na	Cl	NO3
Standard Practice	1.3	0.3	1.8	1634.4	40.7	1.5	0.4	51.4	67.5	78.4	26.8	801.6	0.1	1585.5
Clemens	1.4	0.3	2.0	1685.5	39.4	1.5	0.4	55.9	65.2	81.7	22.4	775.5	0.1	1883.3
Post emergence	1.3	0.3	2.2	1531.1	39.8	1.6	0.4	52.5	50.0	78.5	22.3	780.5	0.1	1983.3
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Cover Crop														
Rye	1.3	0.3	2.2	1578.9	39.4	1.5	0.4	53.5	59.7	78.7	23.1	751.1	0.1	1868.9
Trios	1.3	0.3	1.8	1642.2	39.9	1.5	0.4	58.0	63.5	82.8	24.9	774.7	0.1	1692.2
Bare	1.3	0.3	2.0	1629.9	40.5	1.6	0.4	48.3	59.4	77.1	23.5	829.1	0.1	1891.1
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table 12. Nutrient analysis of grape Leaf Blades, May 22, 2001

Weed Treatment	N	P	K	S	B	Ca	Mg	Zn	Mn	Fe	Cu	Na	Cl	NO3
Standard Practice	3.4	0.3	0.9	5880.3	51.5	1.9	0.3	219.1	381.1	752.3	150.4	677.4	0.1	27.2
Clemens	3.4	0.3	1.0	5752.2	51.6	1.9	0.3	220.1	347.0	738.2	119.8	667.4	0.1	30.4
Post emergence	3.4	0.3	1.1	5533.3	54.6	1.9	0.3	197.1	289.7	694.7	117.0	615.4	0.1	31.4
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Cover Crop														
Rye	3.4	0.3	1.0	5717.8	52.1	1.9	0.3	213.9	339.8	756.0	124.7	635.8	0.1	30.3
Trios	3.4	0.3	1.0	5831.4	53.0	1.9	0.3	212.3	346.0	711.0	131.5	652.5	0.1	25.0
Bare	3.4	0.3	1.1	5616.7	52.7	1.9	0.3	210.0	331.9	718.3	130.9	672.0	0.1	33.8
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table 13. Soil analysis of the vine row berm, June 6, 2002

Weed Treatment	pH	EC	CEC	OM	NO_3	P	K	Cl	B
Standard Practice	7.4	2.8	12.9	0.8	22.3	17.9	202.4	11.2	0.3
Clemens	7.4	2.3	12.5	0.8	20.2	18.0	196.9	8.3	0.3
Post emergence	7.5	3.2	13.2	0.8	23.4	19.3	205.1	13.1	0.3
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Cover Crop									
Rye	7.5	2.1	12.5	0.8	15.8	17.1	198.6	8.6	0.3
Trios	7.5	2.5	13.1	0.8	19.8	17.8	196.8	9.9	0.3
Bare	7.4	3.6	13.0	0.9	30.4	20.2	209.0	14.1	0.3
LSD (0.05)	n.s.	1.5	n.s.	n.s.	8.4	n.s.	n.s.	4.3	n.s.

Table 13 continued. Soil analysis of the vine row berm, June 6, 2002

Weed Treatment	Zn	Cu	Mn	Fe	X-K	X-Na	X-Na	X-Ca	X-Mg
Standard Practice	2.5	1.6	33.6	42.7	0.5	0.6	137.5	8.0	3.3
Clemens	2.0	1.2	28.3	39.2	0.5	0.5	119.4	7.7	3.2
Post emergence	2.9	1.4	27.8	36.7	0.5	0.7	150.8	8.1	3.4
LSD (0.05)	0.5	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Cover Crop									
Rye	2.4	1.4	33.4	42.7	0.5	0.5	121.6	7.7	3.2
Trios	2.3	1.4	26.0	33.4	0.5	0.6	132.0	8.1	3.4
Bare	2.8	1.4	30.3	42.6	0.5	0.7	154.1	7.9	3.3
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table 14. Soil analysis of the row middle, June 6, 2002

Weed Treatment	pH	EC	CEC	OM	NO_3	P	K	Cl	B
Standard Practice	7.1	2.9	12.2	1.0	22.7	23.4	259.6	9.4	0.4
Clemens	7.0	2.3	12.0	1.1	20.8	25.7	261.2	7.6	0.4
Post emergence	7.1	2.7	12.0	1.1	21.1	25.9	276.4	8.2	0.5
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Cover Crop									
Rye	7.2	1.3	11.5	1.1	5.4	22.9	291.5	5.3	0.4
Trios	7.1	1.6	12.0	1.1	11.3	24.1	255.1	6.0	0.4
Bare	7.0	5.0	12.7	1.0	47.9	28.0	250.7	13.9	0.5
LSD (0.05)	n.s.	3.0	n.s.	n.s.	21.5	3.2	n.s.	5.2	n.s.

Table 14 continued. Soil analysis of the row middle, June 6, 2002

Weed Treatment	Zn	Cu	Mn	Fe	X-K	X-Na	X-Na	X-Ca	X-Mg
Standard Practice	2.9	1.6	51.4	60.4	0.7	0.7	157.1	7.5	2.9
Clemens	3.1	1.7	49.1	57.8	0.7	0.6	150.5	7.3	2.8
Post emergence	3.0	1.7	46.4	51.0	0.7	0.7	151.0	7.3	2.8
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Cover Crop									
Rye	2.9	1.7	51.7	60.4	0.8	0.5	113.1	7.1	2.7
Trios	3.0	1.7	52.7	61.7	0.7	0.6	146.8	7.4	2.8
Bare	3.1	1.7	42.4	47.1	0.6	0.9	198.8	7.6	2.8
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	0.2	15.3	0.4	0.3

Table 15. Nutrient analysis of grape petioles, June 6, 2002

Weed Treatment	N	NO_3	NH_4	K	PO_4	P	S	B	Ca	Mg	Zn	Mn	Fe	Cu
Standard Practice	1.0	422.2	400.0	1.8	1092.2	0.2	1530.0	34.2	1.6	0.5	148.2	47.3	52.1	29.1
Clemens	1.1	617.8	480.0	1.8	1226.7	0.2	1603.3	34.2	1.7	0.5	171.0	55.3	60.2	28.2
Post emergence	1.0	463.3	393.3	2.0	985.6	0.2	1463.3	34.3	1.5	0.4	162.0	46.2	54.7	25.3
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Cover Crop														
Rye	1.0	520.0	450.0	2.0	1116.7	0.2	1558.9	34.2	1.6	0.5	165.4	42.5	53.9	26.9
Trios	1.0	424.5	384.5	1.7	1058.9	0.2	1505.5	34.2	1.6	0.5	158.7	49.1	59.4	27.5
Bare	1.0	558.9	438.9	1.9	1128.9	0.2	1522.21	34.3	1.6	0.5	157.1	57.2	53.7	28.4
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table 16. Nutrient analysis of leaf blades, June 6, 2002

Weed Treatment	N	NO_3	NH_4	K	PO_4	P	S	B	Ca	Mg	Zn	Mn	Fe	Cu
Standard Practice	3.1	15.0	128.9	0.9	1204.5	0.3	4674.5	41.8	1.9	0.3	834.7	273.2	506.0	134.8
Clemens	3.1	12.6	122.2	0.9	1317.8	0.3	4728.9	40.0	1.9	0.3	817.2	274.3	466.8	137.5
Post emergence	3.0	12.7	110.0	1.1	1073.3	0.3	4820.0	40.0	1.8	0.3	927.5	300.7	483.8	101.6
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Cover Crop														
Rye	3.1	12.2	126.7	1.1	1208.9	0.3	4697.8	40.1	1.9	0.3	899.8	264.1	450.9	116.9
Trios	3.0	13.1	110.0	1.0	1150.0	0.3	4953.3	42.0	1.8	0.3	879.0	302.2	517.1	125.8
Bare	3.1	14.9	124.4	1.0	1236.7	0.3	4572.2	39.7	1.9	0.3	800.5	281.9	488.5	131.1
LSD (0.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table 17. Vine yield parameters and fruit composition.

Weed Treatment	Yield Kg/vine	Clusters per vine	Cluster weight g	Berry weight *g*	*Brix*	pH	Titratable acidity g/L
Standard Practice	2.83	24	122	1.16	23.9	3.41	6.8
Clemens	2.63	19	144	1.17	23.6	3.41	7.0
Post emergence	3.34	23	150	1.23	23.6	3.45	6.8
LSD (0.05)	ns	ns	ns	ns	0.2	ns	ns
Cover Crop							
Rye	3.11	22	152	1.21	23.8	3.41	6.9
Trios	2.81	23	135	1.20	23.5	3.45	6.8
Bare	2.87	21	129	1.15	23.7	3.43	6.9
LSD (0.05)	ns	ns	ns	ns	0.2	ns	ns

Table 18. Vine growth parameters

Weed Treatment	Shoot number per vine	Pruning weight kg	Fruit : pruning weight ratio
Standard Practice	23	0.51	5.7
Clemens	24	0.53	5.0
Post emergence	24	0.61	5.5
LSD (0.05)	ns	ns	ns
Cover Crop			
Rye	24	0.53	5.6
Trios	24	0.61	5.5
Bare	24	0.51	5.1
LSD (0.05)	ns	ns	ns

Table 19. Total costs for preemergence herbicide practices

Cover Crop	Practices*	Cost/A
Bare Treatment	Herbicide Application – 3x	78
	Disc row middles – 4x	28
	Total Costs	106
Merced Rye	Seed bed preparation/plant cover crop	33
	Herbicide applications – 3x	78
	Mow row middles – 3x	26
	Total Costs	137
Trios 102	Seed bed preparation/plant cover crop	39
	Herbicide applications – 3x	78
	Mow row middles – 3x	26
	Total Costs	143

* Practices (includes materials; labor; equipment; fuel, lube & repairs; interest on operating capital)

Table 20. Total costs for Clemens cultivation weed control practices

Cover Crop	Practices*	Cost/A
Bare Treatment	Clemens cultivation – 5x	42
	Disc row middles – 4x	28
	Hand weed/side disc	43
	Total costs	113
Merced Rye	Seed bed preparation/plant cover crop	33
	Clemens cultivation – 5x	42
	Mow cover crop – 3x	26
	Hand weed/side disc	43
	Total costs	144
Trios 102	Seed bed preparation/plant cover crop	39
	Clemens cultivation – 5x	42
	Mow cover crop – 3x	26
	Hand weed/side disc	43
	Total costs	150

* Practices (includes materials; labor; equipment; fuel, lube & repairs; interest on operating capital)

Table 21. Total costs for postemergence herbicide practices

Cover Crop	Practices*	Cost/A
Bare Treatment	Herbicide application – 4x	59
	Disc row middles – 4x	28
	Total costs	87
Merced Rye	Seed bed preparation/plant cover crop	33
	Herbicide application – 4x	59
	Mow cover crop – 3x	26
	Total costs	118
Trios 102	Seed bed preparation/plant cover crop	39
	Herbicide application – 4x	59
	Mow cover crop – 3x	26
	Total costs	124

* Practices (includes materials; labor; equipment; fuel, lube & repairs; interest on operating capital)

Table 22. Summary of cost matrix for cover crop and weed control strategies

	Weed Control Strategies		
Cover Crop	Preemergence	Clemens	Post emergence
Bare	106	113	87
Merced Rye	137	144	118
Trios 102	143	150	124